

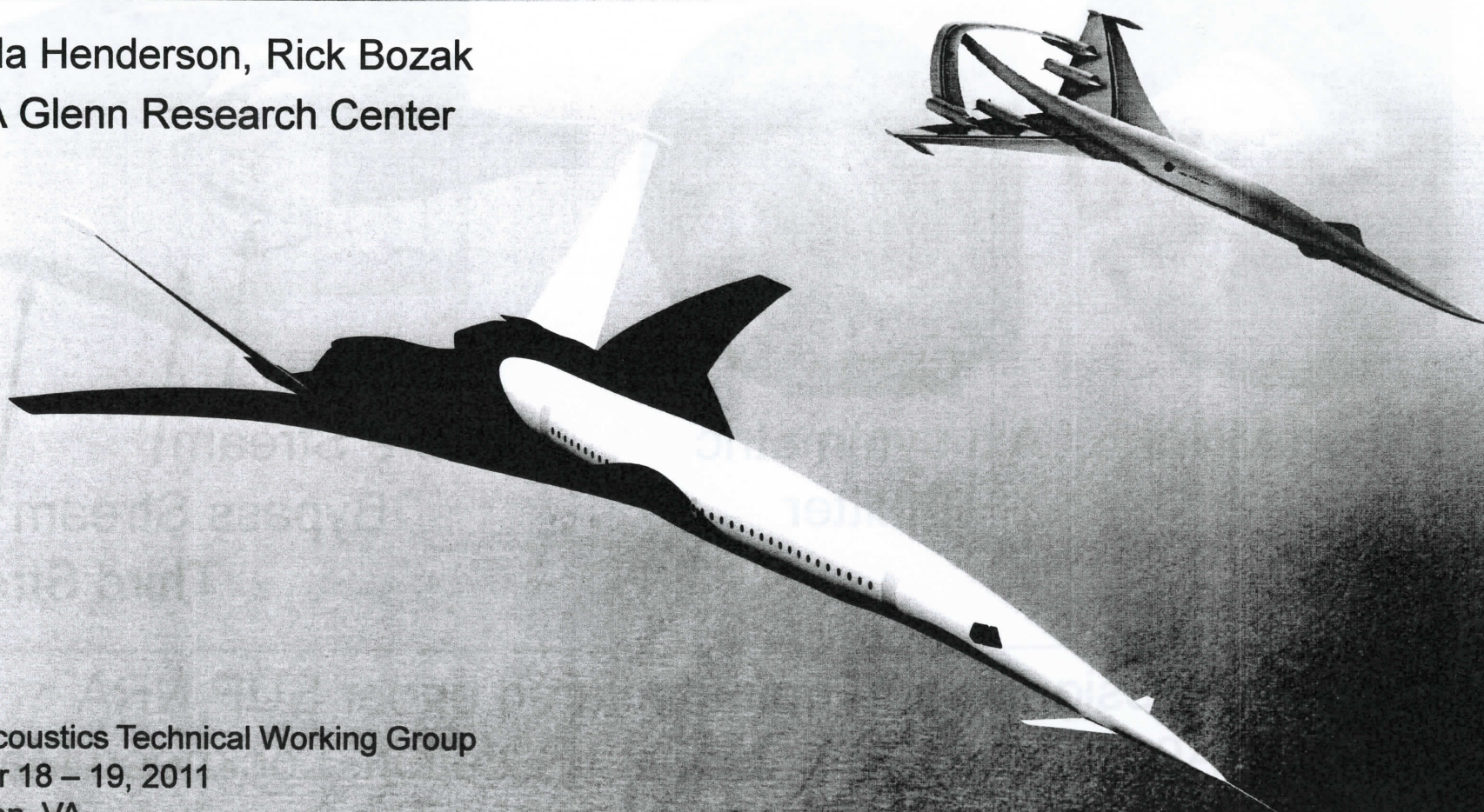
National Aeronautics and Space Administration



Initial Results from Exhaust Noise Tests of Three Streams

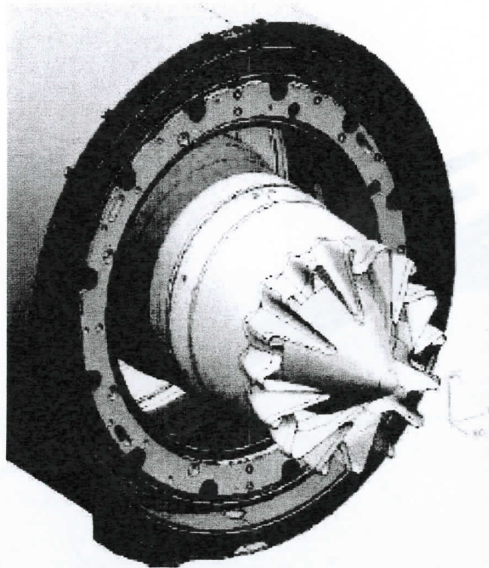
Supersonics Project

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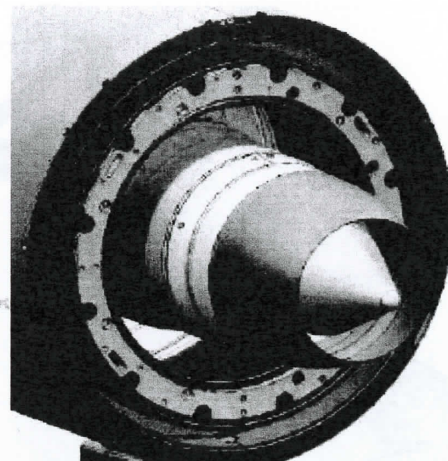


2011 Acoustics Technical Working Group
October 18 – 19, 2011
Hampton, VA
www.nasa.gov

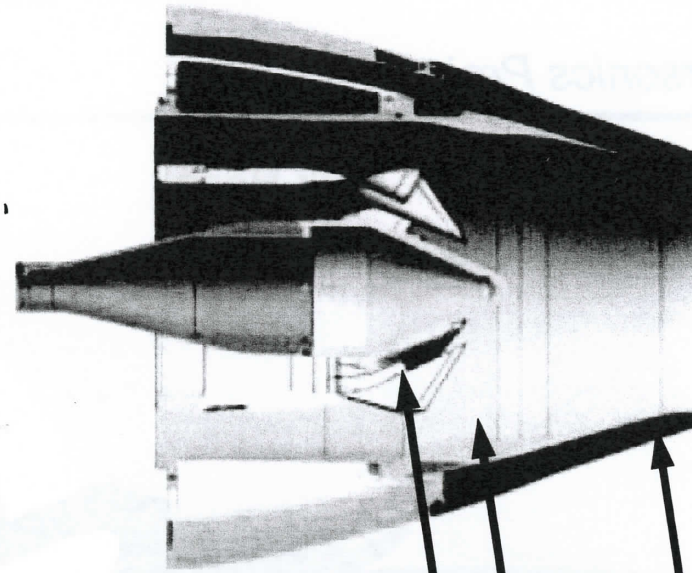
Model



Lobed Mixer



Axi-symmetric
Splitter



Core Stream
Bypass Stream
Third Stream

Hardware designed and manufactured under SUP NRA
NNC10CA02C – N+2 Supersonic Validation, Lockheed Martin

Third Stream Upgrade - Capabilities



- Mass flow rate – 0.5 to 6.0 lbm/sec
- Temperature range – 70° to 250° F (no independent temperature control)
- Controllable plenum outlet pressure – 14 to 30 psia
- Evenly distributed flow (circumferentially) – accomplished with choke plate and Dynapore screens
- Instrumentation
 - plenum static pressure, total pressure, total temperature
 - mass flow - venturi meter

Studies

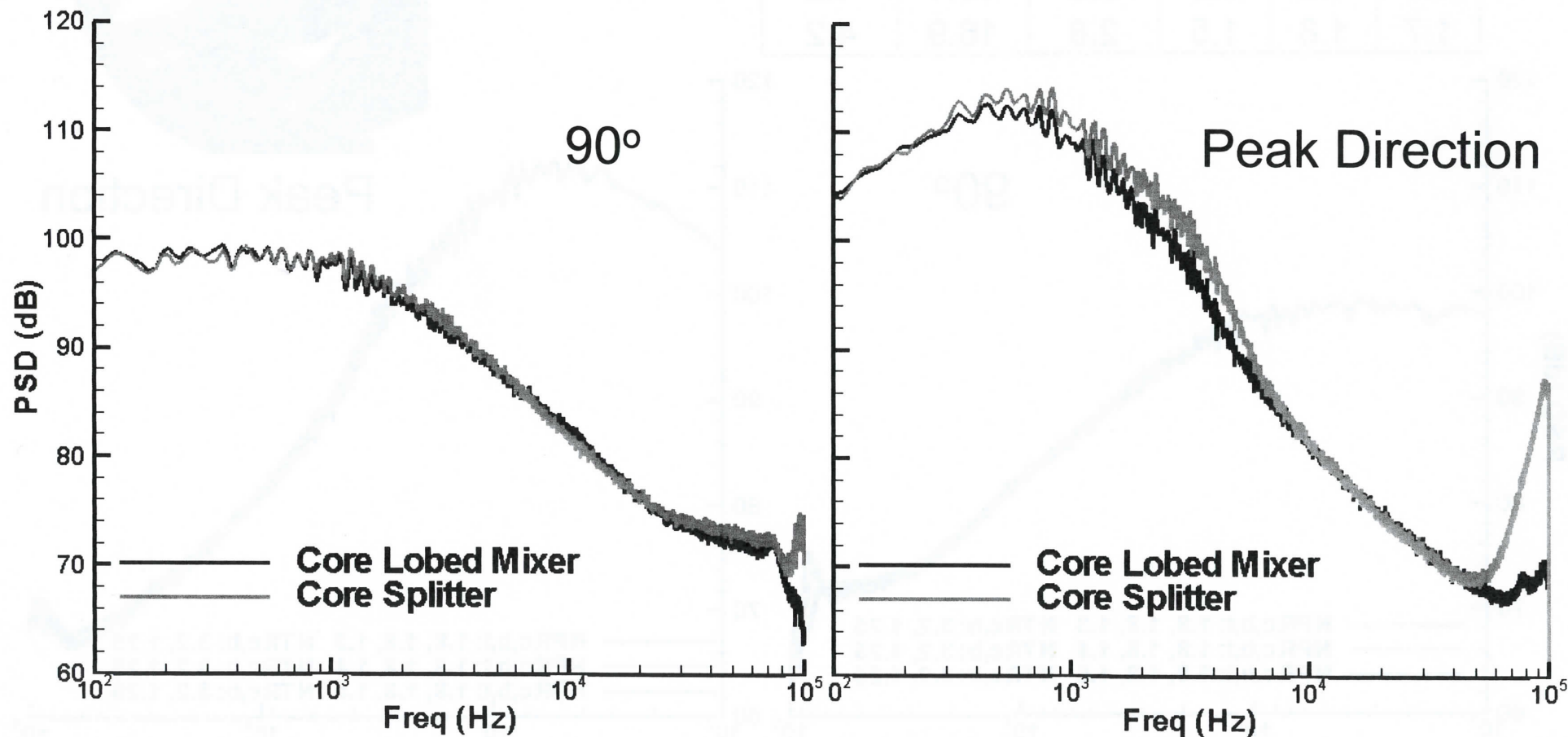


- *Far-field acoustics*
- PIV
 - cross-stream stereo
 - streamwise

Acoustic Results – Mixer vs. Splitter



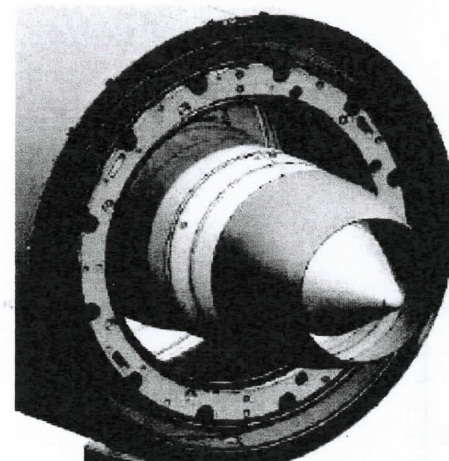
$$M_{fj} = 0.3$$



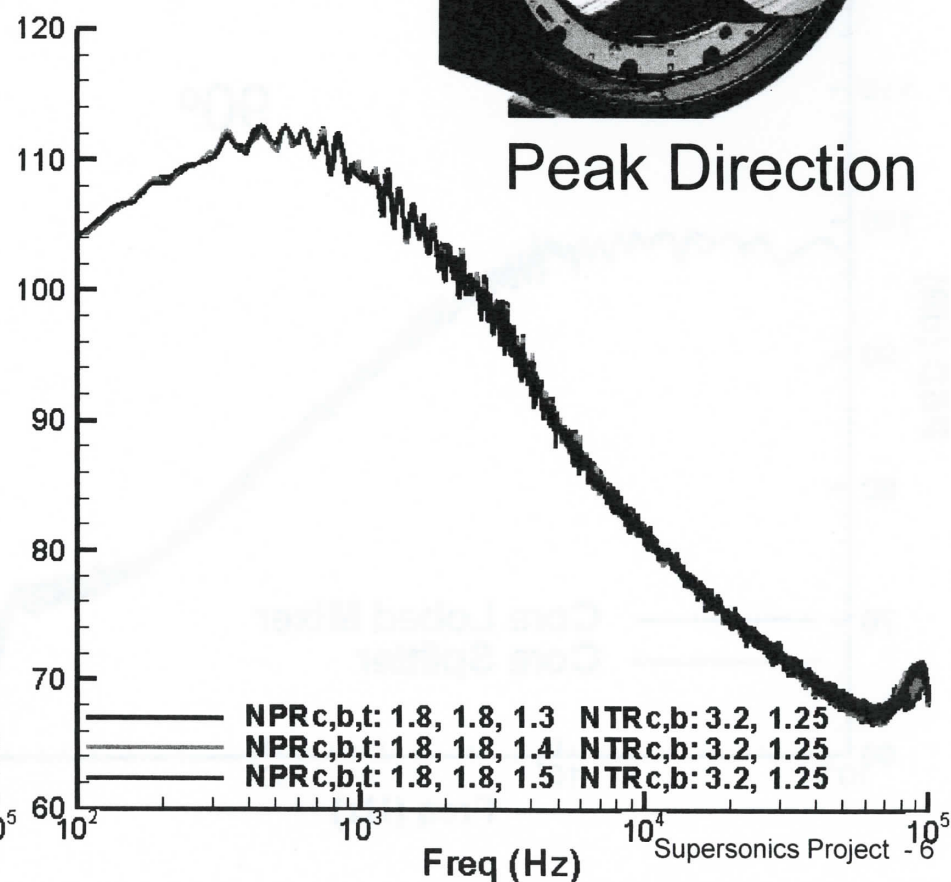
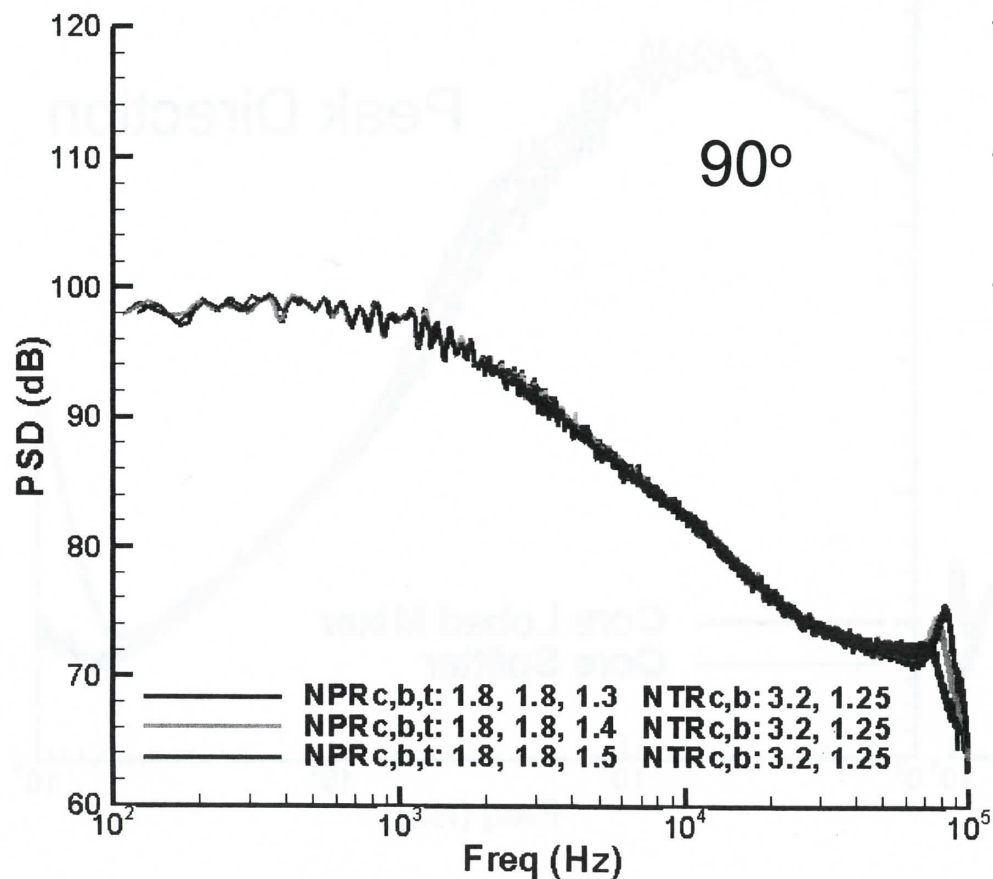
Acoustic Results – Core Splitter

NPR_c	NPR_b	NPR_t	W_c (lbm/s)	W_b (lbm/s)	W_t (lbm/s)
1.8	1.8	1.3	3.5	16.1	3.2
1.8	1.8	1.4	3.5	16.1	3.8
1.8	1.8	1.5	3.5	16.1	4.2
1.7	1.8	1.5	2.8	16.9	4.2

$$M_{fj} = 0.3$$



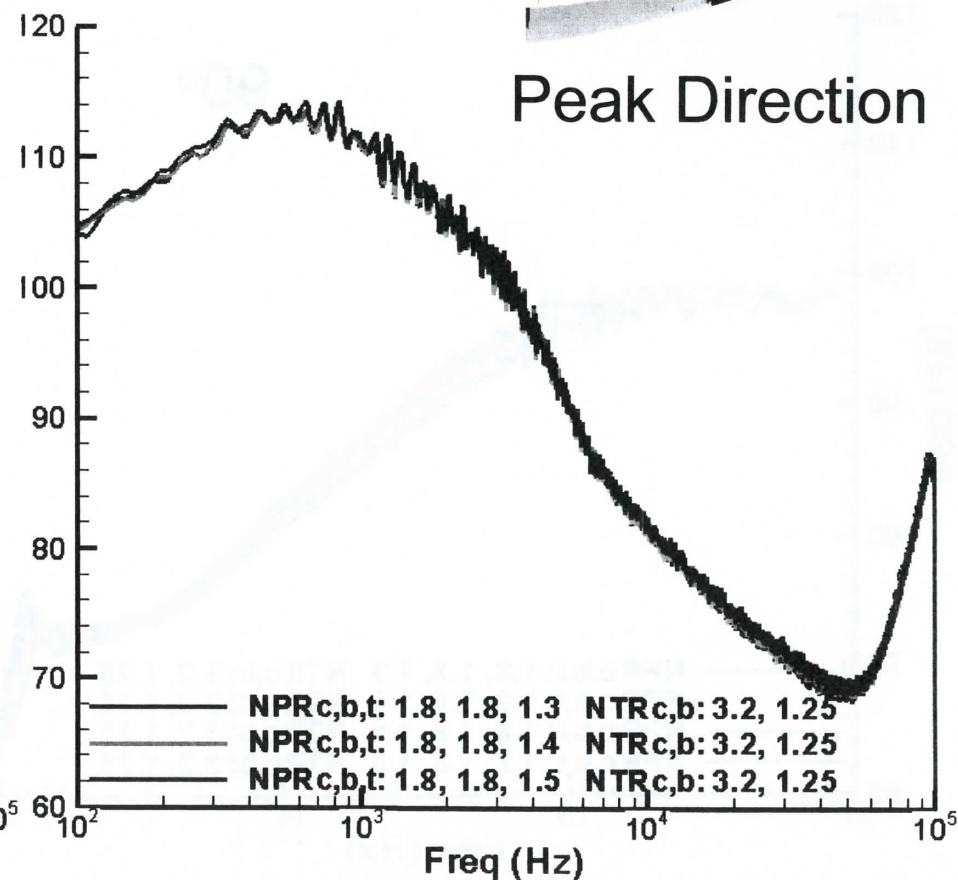
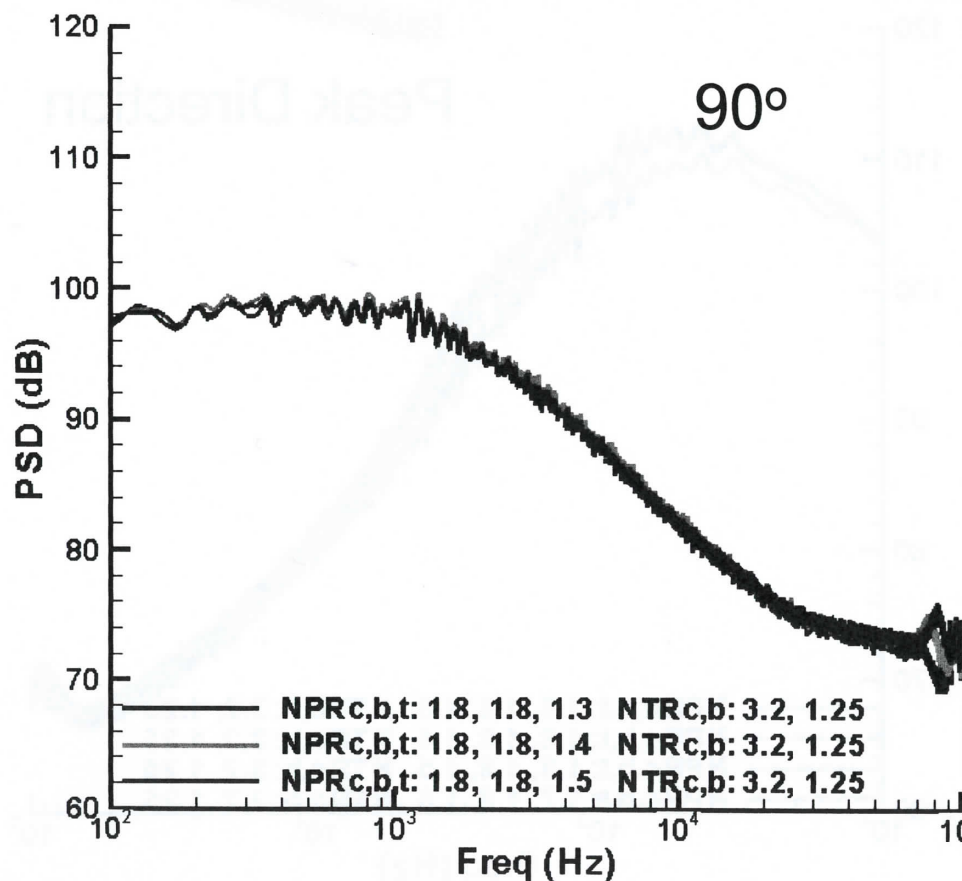
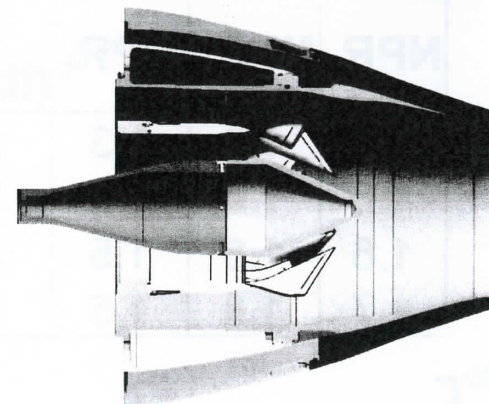
Peak Direction



Acoustic Results – Core Lobed Mixer

NPR_c	NPR_b	NPR_t	W_c (lbm/s)	W_b (lbm/s)	W_t (lbm/s)
1.8	1.8	1.3	3.6	15.5	3.3
1.8	1.8	1.4	3.6	15.5	3.8
1.8	1.8	1.5	3.6	15.5	4.2
1.7	1.8	1.5	2.9	16.3	4.2

$$M_{fj} = 0.3$$

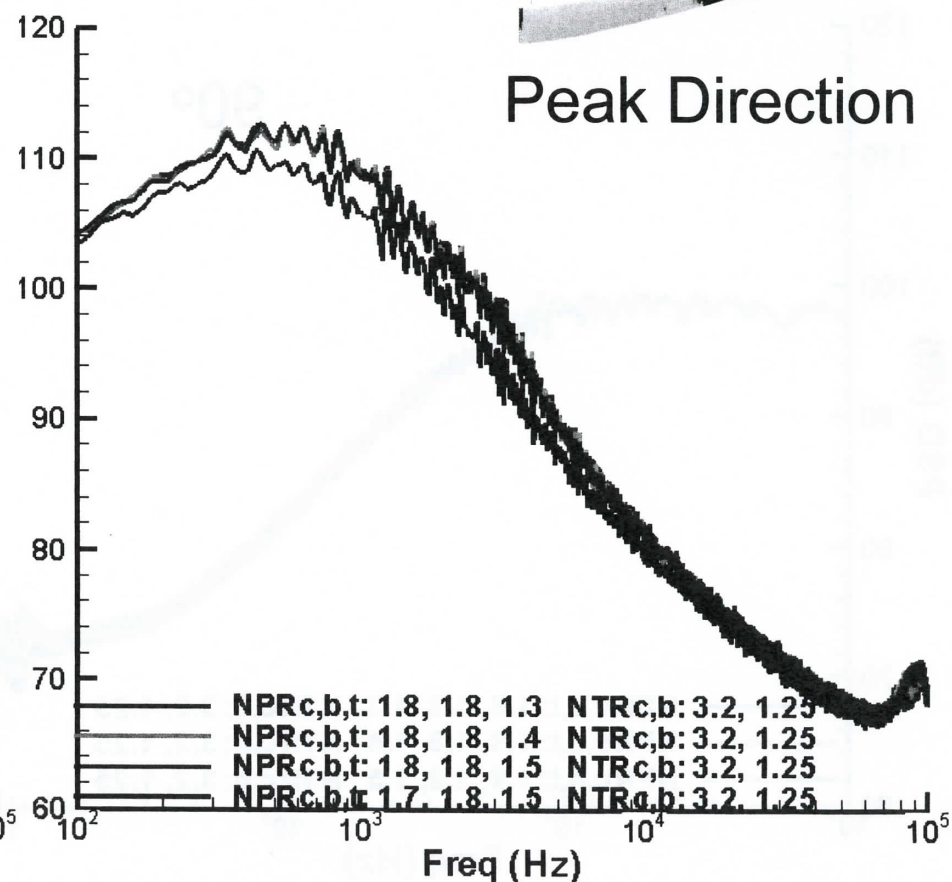
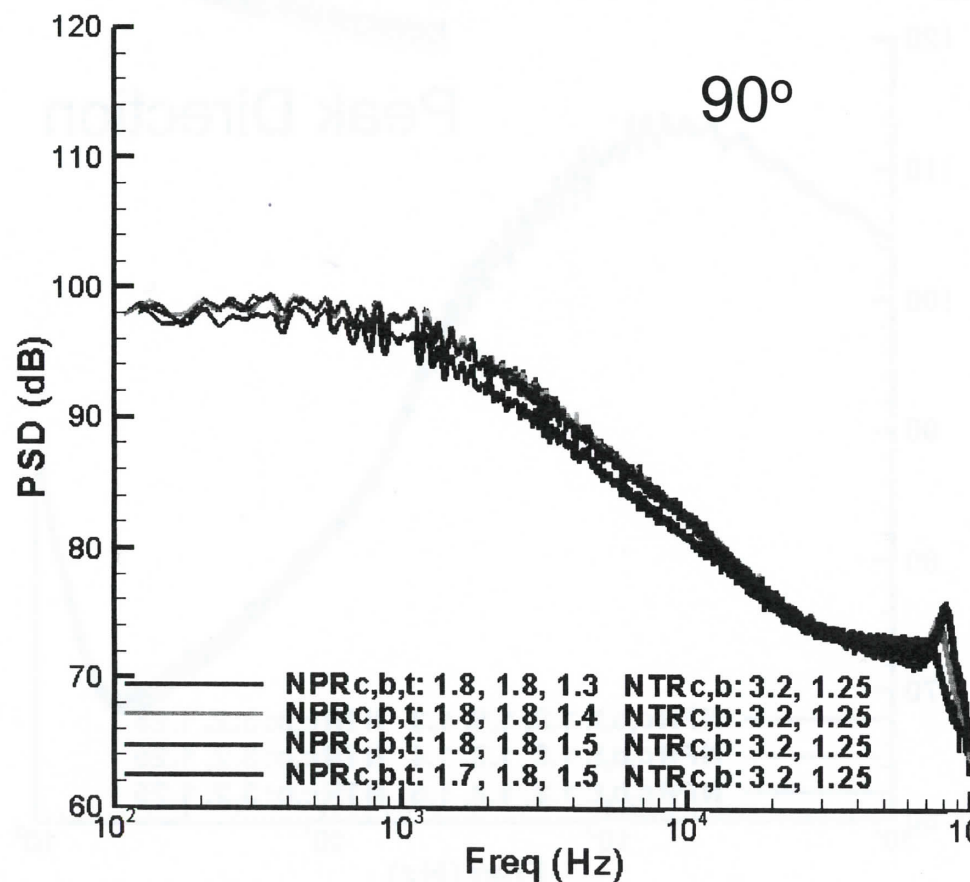
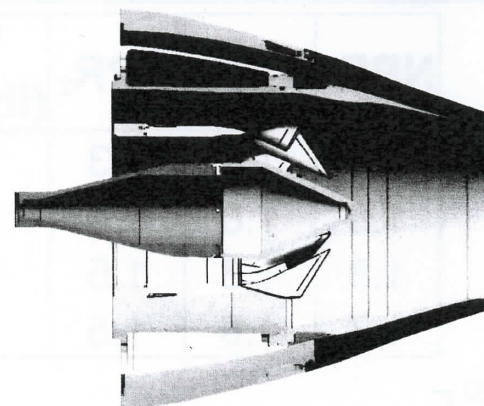


Acoustic Results – Core Lobed Mixer



NPR_c	NPR_b	NPR_t	W_c (lbm/s)	W_b (lbm/s)	W_t (lbm/s)
1.8	1.8	1.3	3.6	15.5	3.3
1.8	1.8	1.4	3.6	15.5	3.8
1.8	1.8	1.5	3.6	15.5	4.2
1.7	1.8	1.5	2.9	16.3	4.2

$$M_{fj} = 0.3$$



Velocity and Thrust



NPR_c	NPR_b	NPR_t	V_b/V_c	V_t/V_b	V_{fj}/V_t	Thrust Increase (%)
1.8	1.8	1.3	0.63	0.68	0.45	
1.8	1.8	1.4	0.63	0.76	0.40	3
1.8	1.8	1.5	0.63	0.83	0.36	5
1.7	1.8	1.5	0.66	0.84	0.36	3

Current Three-stream Experiments



- Experiments conducted October 2011
- Hardware includes core splitter and core lobed mixer
- Experiments include
 - Far-field acoustics
 - PIV
 - Two-component streamwise
 - Cross-stream stereo

Conclusions



- Increase in thrust achieved with addition of third stream without increase in noise
- Database needs to be expanded to understand potential of third-stream for noise reduction